



INTRODUCTION



INTRODUCTION SECTION 1

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SYMBOLS USED IN THIS SECTION

FS	Factor of Safety	1-4
ASTM	American Society for Testing and Materials	1-5
BOCA	Building Officials and Code Administrators International	1-6
ICBO	International Conference of Building Officials	1-6
SBCCI	Southern Building Code Congress International	1-6
ICC	International Code Council	1-6
PISA	Power Installed Screw Anchor	1-8
RR	Round Rod	1-8
SS	Square Shaft	1-8
HS	High Strength	1-9
PIF	Power Installed Foundation	1-9
SLF	Street Light Foundation	1-9
T/C	Tension/Compression	1-9
ICC-ES	ICC Evaluation Service, Inc.	1-12
kips	Kilopound	1-13

DISCLAIMER

The information in this manual is provided as a guide to assist you with your design and in writing your own specifications.

Installation conditions, including soil and structure conditions, vary widely from location to location and from point to point on a site.

Independent engineering analysis and consulting state and local building codes and authorities should be conducted prior to any installation to ascertain and verify compliance to relevant rules, regulations and requirements.

Hubbell Power Systems, Inc., shall not be responsible for, or liable to you and/or your customers for the adoption, revision, implementation, use or misuse of this information. Hubbell, Inc., takes great pride and has every confidence in its network of installing contractors and dealers.

Hubbell Power Systems, Inc., does NOT warrant the work of its dealers/installing contractors in the installation of CHANCE® Civil Construction foundation support products.

DEFINITION of ATLAS RESISTANCE® PIERs

The ATLAS RESISTANCE® Pier utilizes the weight of the structure as its reaction system to drive or push the pipe pier sections into the soil. Hubbell/CHANCE® has developed a lasting solution for many distressed foundation problems through its patented and tested ATLAS RESISTANCE® Pier System. The pier is an assembly of structural steel components that include a pier head assembly attached to the foundation or slab, which is then mounted on a steel pier that is installed to bedrock or firm bearing stratum. The unique friction reduction collar on the



lead section of the pier reduces skin friction on the pier pipe during installation. The pier capacity is primarily from end bearing on a hard/dense soil stratum. The ATLAS RESISTANCE® Pier has been successfully driven to depths of 200 feet to ensure proper and verified support.

Hubbell Power Systems, Inc. offers a broad range of applications for ATLAS RESISTANCE® Piers, including foundation underpinning and slab underpinning applications.

The ATLAS RESISTANCE® Pier is a manufactured, two-stage product designed specifically to produce structural support strength. First, the pier pipe is driven to a firm bearing stratum; then the lift equipment is typically combined with a manifold system to lift the structure (if required). This procedure provides measured support strength. Piers are spaced at adequate centers where each pier is driven to a suitable stratum and then tested to a force greater than required to lift the structure. This procedure effectively load tests each pier prior to lift and provides a measured Factor of Safety (FS) on each pier at lift.

Workspace is not normally a problem when using ATLAS RESISTANCE® Piers. They can be installed using portable equipment in an area that measures approximately three feet square. The pier may be installed from the interior or on the exterior of the footing.



HISTORY of PUSHED STEEL PILE SYSTEMS

The history of piling systems extends back to the ancient Greek, Roman and Chinese societies. Although numerous methods and materials have been utilized throughout the centuries, modern construction methods and practices have mandated the repair and remediation techniques of today's structures. The use of excavated foundations, footings, walls and beams, although providing adequate support in some soil conditions, have proven to be less desirable in a multitude of soil and site profiles. Fill areas, compressible soils, organics and expansive soils offer a greater challenge in the long term stability of foundations and are an underlying cause of billions of dollars of structural remedial repairs worldwide. The need for deep foundation underpinning systems increased dramatically in the 20th century with the building booms and growth in metropolitan areas.



In 1896, Jules Breuchaud, a contractor and civil engineer residing in New York, patented an “improved method of underpinning the walls of existing buildings” by a system of driving hollow, tubular column sections to bedrock or other firm strata using hydraulic jacks and a transverse beam system. Two sets of columns driven at opposite sides of the wall and beneath a transverse beam or beams utilized “the superincumbent weight of the building to resist the pressure of the hydraulic jacks, whereby the latter exerts a very powerful force in driving the column sections to bearing strata”. This method allowed for permanent or temporary support and raising or lowering of structures by patent definition.

In 1897, Richard S. Gillespie, another New York entrepreneur, patented a similar method of underpinning existing buildings by means of a reaction, or “pressure-resisting” column that provided the reaction force to drive “cylindrical columns” using a system of cantilevered beams, tie-rods and hydraulic rams restrained to the reaction column to allow for sinking pipe sections to bearing strata for support. This cantilevered approach allowed for placement of pipe supports beneath the middle of the building wall in lieu of the twin-column method developed by Breuchaud and also provided a method for driving deep foundation piles for new construction.

Another substantial advancement was developed and patented by Lazarus White, again of New York, in 1917. White addressed long-term stability issues encountered in previous similar methods by introducing the practice of pre-loading or as he termed it “the first or temporary load” encountered from the reaction during pushing the pipe against the structure load to a pre-determined capacity equal to 150% of the required load which is consistent with the installation methodology ATLAS RESISTANCE® Piers use today. Additionally, White also documented theories of the soil “pressure bulb”

created at the pile tip which assumes compression of the soil beyond the periphery of the pile for contributing to “a load in excess of that attributable to the resistance of the area of the end of the pile”.

One early documented adaptation incorporating the use of a steel, eccentrically loaded bracket with pushed piles as a load transfer method was revealed in a 1959 patent application by Guy Henry Revesz and Jack C. Steinsberger of Illinois. This patent, which was recognized in 1961, cited references to the early work of Breuchaud and Gillespie. The method of 150% pre-loading which was prevalent in the White Patent of 1917 is also a standard criterion in this 1961 patent methodology. Numerous similar patents for pushed or jacked piers surfaced in the 60’s and 70’s, further extending the work of these early pioneers.

APPLIED RESEARCH and DEVELOPMENT

The development of the ATLAS RESISTANCE® Pier system early in the 1980’s created new opportunities for building owners to reclaim the hard-earned equity of their structure’s previously de-valued state as a result of settlement. Since the ATLAS RESISTANCE® Pier is designed to actually restore the structural integrity and original elevation, building values and salability are usually recovered. Their two stage installation method provides

validation of load capacity along with a verifiable Factor of Safety for each pier installed.

Essentially, every single pier is load tested during the installation process. The friction reduction collar on the lead pier section reduces skin friction during installation which allows less driving force to be required to reach the bearing stratum. From the early three-piece ATLAS RESISTANCE® Pier System patent, numerous products and specialty equipment have been developed to serve the industry. The ATLAS RESISTANCE® 2- Piece, Plate Pier, Continuous Lift and Pre-Drilled systems represent the flexibility in design and application of the ATLAS RESISTANCE® product line. New applications and modifications of these systems are continually in a state of expansion and growth to meet the needs of the deep foundation industry and to maintain the "state of the art" status and reputation of the ATLAS RESISTANCE® Product line.

ATLAS RESISTANCE® Piers have earned the support of the engineering community through years of focus on engineering, preliminary design, continuing education through formal training and overall team effort philosophy of Hubbell Power Systems, Inc., its application engineers and its installing contractor force. The broad Hubbell Power Systems, Inc. product line is a direct result of the effort and interaction of innovative

engineers, installing contractors and owners to provide sound, economical solutions to structure settlement in a multitude of environments throughout the country.

TESTING and CODE COMPLIANCE

ATLAS RESISTANCE® Pier products have been subjected to full scale load tests under actual field conditions to determine their ultimate capacity. These tests were designed, conducted and certified under the direction by Dr. David C. Kraft, Ph.D., PE. The field load tests were carried out in close conformance to ASTM D1143-81, Piles under Static Axial Compressive Load. These field load tests were conducted in Independence, Missouri between June 3, and July 6, 1989.

ATLAS RESISTANCE® Models AP-2-3500.165 and AP-2-3500.165(M) comply with the structural provisions of the most recent editions of the Building Officials and Code Administrators International (BOCA) National Code, International Conference of Building Officials (ICBO) Uniform Code, Southern Building Code Congress International (SBCCI) Standard Code and the 2000 International Building and Residential Codes of the International Code Council (ICC) with the new 2002 Accumulative Supplement. A copy of this evaluation report, NER-579, is available online at www.abchance.com.





APPLICATIONS

ATLAS RESISTANCE® Piers are used primarily for underpinning and the repair of residential and commercial buildings, retaining structures and slabs. They can be installed in either interior or exterior locations. They have been used to repair equipment and machinery foundations, warehouse buildings, tower foundations, etc. Special remedial repair brackets can be connected to either the bottom or side of an existing foundation. They can also be connected to the sides of circular or flat building columns. ATLAS RESISTANCE® Piers not only stop settlement, but can also be used to raise the structure, thus closing cracks and correcting other structural flaws resulting from settlement and/or ground movement. The design process should involve professional engineering input. Specific information involving the structure, soil characteristics and foundation conditions must be evaluated and incorporated into the final design.

ADVANTAGES of ATLAS RESISTANCE® PIERS

The advantages of ATLAS RESISTANCE® Piers are similar in nature to those cited later in this section for CHANCE® Helical Piles/Anchors. They are used when a deep foundation solution is required. They are installed with light weight, portable equipment that allows for installations in limited access areas and in low overhead conditions. Their installation is not weather dependent. They are ideal in contaminated soil areas, since no soil has to be removed for installation. Table 1-1 summarizes some of the advantages of ATLAS RESISTANCE® Piers.

ATLAS RESISTANCE® PIER ADVANTAGES, TABLE 1-1

Summary of ATLAS RESISTANCE® Pier Advantages	
<ul style="list-style-type: none"> • No need for concrete to cure • Fast turnkey installation • Immediate loading • Equipment portability • Pre-engineered system • Easily field modified • On site load test on each pier • Two stage installation for load capacity checks 	<ul style="list-style-type: none"> • All weather installation • Solution for: <ul style="list-style-type: none"> - Restricted access sites - High water table - Weak surface soils • Environmentally friendly • No vibration • No spoils to remove



DEFINITION of HELICAL PILES/ANCHORS

The helical pile/anchor is basically a deep foundation system used to support or resist any load or application. Installed by mobile equipment ranging in size from lightweight units to heavier units depending on the load requirements, it can be loaded immediately. The helical pile/anchor's elegant simplicity is its greatest asset. Its mechanical design and manufacture balance the capacities of its three basic parts and maximize the efficient use of their material.

Essential Elements:

1. *At least one bearing plate (helix)*

Dies form each steel bearing plate into a true helix. The plates are formed in a true helical shape to minimize soil disturbance during installation (as opposed to the inclined plane of an auger which mixes soil as it excavates). Properly formed helical plates do not measurably disturb the soil. The helical bearing plates transfer the load to the soil bearing stratum deep below the ground surface. Hubbell Power Systems, Inc. defines "deep" as five helix diameters vertically below the surface where the helical plate can develop full capacity of the plate-to-soil interaction.

2. *A central shaft*

During installation, the central steel shaft transmits torque to the helical plate(s). The shaft transfers the axial load to the helical plate(s) and on to the soil bearing stratum. Theoretically, the shaft needs to be larger than the shaft material's allowable stress. Realistically, the shaft also needs to be strong enough to resist the torque required for installation and large enough in section for the soil to resist buckling, if used in a compression application.

3. *A termination*

The termination connects the structure to the top of the helical pile/anchor transferring the load down the shaft to the helical plate(s) to the bearing soil. To evenly distribute the structure load to the helical piles/anchors, the termination may be a manufactured bracket or an attachment produced on site as designed by the structural engineer. Such aspects dictate the termination's configuration as a function of its application and may range from a simple threaded bar to a complex weldment, as is appropriate to interface with the structure.

HISTORY and SCIENCE of CHANCE® HELICAL PILES/ANCHORS

In 1833, the helical pile was originally patented as a "screw pile" by English inventor Alexander Mitchell. Soon after, he installed screw piles to support lighthouses in tidal basins of England. The concept also was used for lighthouses off the coasts of Maryland, Delaware and Florida.

Innovations of the helical pile/anchor have been advanced by both its academic and commercial advocates. Considerable research has been performed by public and private organizations to further advance the design and analysis of helical piles and anchors. A partial list of publications related to helical pile research is included at the end of this chapter. Much of the research was partially funded or assisted by Hubbell Power Systems,

Inc. Contributions of financial, material and engineering support for research ventures related to helical piles is continued today by Hubbell Power Systems, Inc.

Today, readily available hydraulic equipment, either small or large, can install helical pile/anchors almost anywhere. Backhoes, skid-steer loaders and mini-excavators are easily fitted with hydraulically driven torque motors to install helical pile/anchors in construction sites inaccessible by the larger equipment required for other deep foundation methods. According to site conditions, installation equipment can include guided-head and articulated-head torque-head machinery, self-propelled, carrier-mounted, tracked, wheeled or floating.

The following summarizes a short list of Hubbell Power Systems, Inc. contributions to the helical pile/anchor industry. In 1940, the A.B. Chance Company sold the first commercially offered helical anchor tension application. It was installed by hand using a small tubular wrench. Other early developments include soil classifying measurement devices.

- **PISA® (Power Installed Screw Anchors)**

In the late 1950's, the A.B. Chance Company introduced the patented PISA® system. This coincided with the invention of truck-mounted hole-digging equipment following World War II. The PISA® system has become the worldwide method of choice for guying pole lines of electric and telephone utilities.

The PISA® system's all-steel components include one or two helix plates welded to a square hub, a rod threaded on both ends, a forged guy wire eye nut, and a special installing wrench. The square-tube anchor wrench attaches to the kelly bar of a digger truck, fits over the rod, engages the helical hub and typically installs a PISA® anchor in 8 to 10 minutes. Rod and wrench extensions may be added to reach soil layers which develop enough resistance to achieve capacity. PISA® rods come in 5/8", 3/4" and 1" diameters.

Through A.B. Chance Company testing and close contact with utilities, the PISA® anchor family soon expanded to develop higher strengths capable of penetrating harder soils including glacial till. This quickly gave rise to the development of CHANCE® Helical Piles/Anchors with higher capacities and larger dimensions.



More recent developments include the SQUARE ONE® (1980) and the TOUGH ONE® (1989) patented guy anchor families with 10,000 and 15,000 ft-lb installing torque capacities. Unlike previous PISA® designs, these anchor designs are driven by a wrench that engages inside, rather than over, their welded socket hubs. Both use the PISA® extension rods with threaded couplings.

- **Round Rod (RR) Anchors**

In 1961, the A.B. Chance Company developed extendable Type RR multi-helix anchors, originally for use as tiedowns for underground pipelines in poor soil conditions on the Gulf of Mexico coast. These anchors are not driven by a wrench; instead, installing torque is applied directly to their 1-1/4" diameter shafts. Type RR anchors worked well in weak surficial soils, but their shaft (although extendable by plain shafts with bolted upset couplings) did not provide enough torque strength to penetrate very far into firm bearing soils.

- **Square Shaft (SS) Anchors**

Development of a high-torque, shaft-driven, multi-helix anchor began in 1963, culminating in the introduction of CHANCE® Type SS 1½" Square Shaft multi-helix anchors in 1964-65. The SS anchor family since has expanded to include higher-strength 1-3/4", 2" and 2-1/4" square shafts. With the acquisition of Atlas Systems, Inc., in 2005, the Type SS product

line has been expanded to include 1-1/4" square shafts. Extension shafts with upset sockets for the 1-1/4", 1-1/2", 1-3/4", 2" and 2-1/4" square shafts also lengthen these anchors to penetrate most soils at significant depths for many civil construction applications including guying, foundations, tiebacks and more recently, soil nails (the CHANCE SOIL SCREW® Retention Wall System, 1997).

- **High Strength (HS) Anchors/Piles [now called Round Shaft (RS) Piles]**

Later in the 1960's, Type HS anchors developed first for high-torque guying requirements later were applied as foundation helical piles for utility substations and transmission towers. The HS anchor family has 3-1/2" pipe shafts which may be lengthened by extensions with swaged couplings. HS anchors now are used for a wide array of foundation applications. The Type HS Piles/Anchors are now referred to as Type RS Piles/anchors. Hubbell Power Systems, Inc. now offers 2-7/8" (RS2875.203, RS2875.276), 4-1/2" (RS4500.337), 6" (RS6625.280) and 8" (RS8625.250) pipe shafts in addition to the 3-1/2" (RS3500.300).

- **Power Installed Foundation (PIF) Anchors/Piles**

Also launched in the 1960's were non-extendable anchors termed Power Installed Foundations. PIF sizes and load capacities support requirements for foundations that support a broad range of equipment, platforms and field enclosures. Most versatile are the 5-ft to 10-ft-long PIFs with pipe shafts of 3-1/2", 4", 6-5/8", 8-5/8" and 10-3/4" diameters, each with a single helix of 10", 12", 14" or 16" diameter. Integral base plates permit direct bolt-up connections on either fixed or variable bolt-circle patterns.

Bumper post anchors are similar to the 3 1/2"-shaft PIF, but with fence-type caps instead of base plates, to serve as traffic barriers around booths, cabinets, doorways, etc. One with a 2-3/8" pipe shaft 69" long is called a Square Drive Foundation for its 2"-square drive head. The solid head is internally threaded for adding a straight stud or adjustable leveling pad after installation.

- **Street Light Foundation (SLF) Anchors/Piles**

In 1972, CHANCE® Street Light Foundations (SLF) were introduced. Anchors with pipe shaft diameters of 6-5/8", 8-5/8" and 10-3/4" in fixed lengths of 5, 8 and 10 feet. Complete with an internal cableway, these foundations with bolt-up base plates deliver the quick solution their name implies and now are used to support similar loads for a variety of applications.



- **Helical Pier Foundation Systems/Piles**

In 1985, CHANCE® patented products for repairing foundations of all residential and commercial buildings were introduced. Originally based on Type SS helical anchors, its special foundation repair brackets transfer structural loads to stable soil strata below weak surface conditions. Since then, the product also has been used to deepen foundations for new construction by installing the helical piles at intervals between footing forms prior to pouring reinforced concrete.

- **CHANCE HELICAL PULLDOWN® Micropiles**

Developed in 1997, for sites with especially weak surface soils, this patented innovative application of the helical pile integrates portland-cement-based grout to stiffen the shaft. By "pulling down" a special flowable grout as the foundation is screwed into the soil, the result is a pile with both a friction-bearing central shaft and end-bearing helical plates in competent substrata. Where needed for poor surface conditions, this performance combination converts sites previously deemed as "non-buildable" to usable sites suited for not only building construction but also telecom tower foundations in areas inaccessible by equipment utilized for other

deep foundation methods. It employs SS, RS and combinations of these two types of helical piles.

- **Large Diameter Pipe Piles (LDPP)**

To meet an industry need for helical piles with higher tension/compression capacities and larger bending resistance, the large diameter pipe pile research project was initiated in 2007. The research culminated in product offerings including extendable large diameter piles with a box coupling system capable of installation torques as high as 60,000 ft-lbs and compression capacities of 300 kips.

APPLIED RESEARCH and DEVELOPMENT

In addition to products developed for specific applications, significant contributions to the applied science of helical piles and anchors by Hubbell Power Systems, Inc. have been achieved. Among the various subjects which have expanded the body of knowledge are:

- **CHANCE® Civil Construction Soil Classification**

In 1945, A.B. Chance Company listed the first earth anchoring manual, which classified soils according to holding capacities as related to proper anchor selection. At sites where soil data was available, either by sample excavation or some rudimentary means of probing subsurface strata, this chart imparted a valuable basis for recommending the proper helical pile or anchor for a given load.

CHANCE® CIVIL CONSTRUCTION SOIL CLASSIFICATION , TABLE 1-2

Class	Common Soil-Type Description	Geological Soil Classification	Probe Values in/lbs (nm)	Typical Blow Count N per ASTM D1586
0	Sound hard rock, unweathered	Granite, Basalt, Massive Limestone	N.A	N.A
1	Very dense and/or cemented sands; coarse gravel and cobbles	Caliche, (Nitrate-bearing gravel/rock)	750-1600 (85-181)	60-100+
2	Dense fine sands; very hard silts and clays (may be preloaded)	Basal till; boulder clay, caliche; weathered laminated rock	600-750 (68-85)	45-60
3	Dense sands and gravel; hard silts and clays	Glacial till; weathered shales, schist, gniess and siltstone	500-600 (56-68)	35-50
4	Medium dense sand and gravel; very stiff to hard silts and clays	Glacial till; hardpan; marls	400-500 (45-56)	24-40
5	Medium dense coarse sands and sandy gravels; stiff to very stiff silts and clays	Saprolites, residual soils	300-400 (34-45)	14-25
6	Loose to medium dense fine to coarse sands to stiff clays and silts	Dense hydraulic fill; compacted fill; residual soils	200-300 (23-34)	7-14
**7	Loose fine sands; Alluvium; loess; medium-stiff and varied clays; fill	Flood plain soils; lake clays; adobe; gumbo, fill	100-200 (11-23)	4-8
**8	Peat, organic silts; inundated silts, fly ash very loose sands, very soft to soft clays	Flood plain soils; lake clays; adobe; gumbo, fill	less than 100 (0-11)	0-5

Class 1 soils are difficult to probe consistently and the ASTM blow count may be of questionable value.

* Probe values are based on using CHANCE® Soil Test Probe, catalog number C309-0032

** It is advisable to install anchors deep enough, by the use of extensions, to penetrate a Class 5 or 6, underlying the Class 7 or 8 Soils.



• Torque-to-Capacity Relationships

Installation torque-to-load capacity relationship is an empirical method that the A.B. Chance Company originally developed in the 1960's. The idea was that the installation energy (torque) required to install a helical pile/anchor can be correlated to its ultimate load capacity in soil. The analogy is similar to screwing a wood screw into a piece of wood. It takes more torsional energy to screw into dense wood, such as oak, than it does to screw into a soft wood, such as pine. Likewise, a wood screw in oak will require more effort to pull out than the same wood screw in pine. The same is true for helical piles/anchors in soil. Dense soil requires more torque (more energy) to install compared to a soft soil; and likewise dense soil will generate higher load capacity compared to a soft soil.

For the torque correlation method to work, torque must be measured. Hubbell Power Systems, Inc. Engineers have developed both mechanical and electronic indicators over the years, many of which are commercially available for torque measurement in the field. The most recent addition to the product line is the C3031578 Digital Torque Indicator, which features a continuous reading digital readout of installation torque up to 30,000 ft-lb. The Digital Torque Indicator is also available with a wireless remote display and a data logger. The data logger records torque and other installation data that is used as a permanent record.

• Soil Mechanics Principles

In the 1970s and early 1980s, changes in design philosophy led Hubbell Power Systems, Inc. Engineers to recognize that a deep buried plate (i.e., pile/anchor helix) transferred load to the soil in end-bearing. Theoretical capacity could then be calculated based on Terzaghi's general bearing capacity equation. The individual bearing method, discussed in detail in Section 5, calculates the unit bearing capacity of the soil and multiplies it by the projected area of the helix plate. The capacity of individual helix plate(s) is then summed to obtain the total ultimate capacity of a helical pile/anchor. Today, the individual bearing method is commonly used in theoretical capacity calculations and is recognized as one method to determine helical pile capacity in the International Building Code (IBC).



• 100+ Years of Field Test Data

Hubbell Power Systems, Inc. Engineers continuously prove theory by conducting literally thousands of load tests in the field. It has been said that soil occurs in infinite variety of engineering properties can vary widely from place to place. This variability makes in-situ testing a vital part of sound geotechnical engineering judgment. Test results are available from Hubbell Power Systems, Inc. for typical capacity of helical piles/anchors in soil.

• HeliCAP® Helical Capacity Design Software

Hubbell Power Systems, Inc. Engineers developed HeliCAP® Helical Capacity Design Software to assist the designer to select the correct helical lead configuration and overall pile/anchor length. It



also estimates the installation torque. This program makes the selection of helical piles/anchors easier and quicker than hand calculations. To obtain a copy of the software, please contact your local Hubbell Power Systems, Inc. Distributor. Contact information for each distributor can be found at www.abchance.com.

- **SELECT-A BASE™ Lighting Base Program**

The SELECT-A BASE™ Lighting Base Program is an on-line program developed in 2009 by Hubbell Power Systems, Inc. Engineers for preliminary foundation selection for roadway, area, and site lighting poles and luminaires. The program incorporates a database of CHANCE® Lighting Bases designed using more than 100 years of research, development and testing of earth anchor systems. The program inputs include loading conditions (wind, moment, and/or lateral), pole/pole arm details and soil data. The software is free and easy to use on-line at www.abchance.com.

- **Inter-Helix Spacing**

Load transfer either above or below the helix plate results in a stress zone within a defined soil volume. For individual bearing to work properly, the helix plates must be spaced far enough apart to avoid overlapping their stress zones. The key is to space the helix plates just far enough apart to maximize the bearing capacity of a given soil. This works to reduce the overall length of the helical pile/anchor and increases the likelihood for all helix plates to be located in the same soil layer; which in turn leads to more predictable torque-to-capacity relationships and better load/deflection characteristics. Through years of research, the Hubbell Power Systems, Inc. Engineers determined that the optimal spacing for helix plates is three diameters. More specifically, the optimum space between any two helical plates on a helical pile/anchor is three times the diameter of the lower helix. Today, all CHANCE® Helical Piles/Anchors are manufactured using the industry standard of three diameter spacing.

- **Industry Standard: Helical Pile/Anchor Form Fits Function**

The helical pile/anchor is not a complex product, but it continues to serve ever-expanding roles in civil construction applications. However, you will probably not find helical piles/anchors mentioned in most foundation engineering textbooks; and as such familiarity with helical piles/anchors is still lacking among most civil and structural engineers with a foundation background. This trend is slowly changing. Since the first edition of this technical manual, helical piles are now listed as a deep foundation system in the 2009 and 2012 editions of the International Building Code. In addition, ICC-ES Acceptance Criteria AC358 for Helical Systems and Devices was published in 2007 and is now on its third revision. Hubbell Power Systems, Inc. was the first manufacturer of helical piles and anchors to obtain evaluation reports from all three model building code agencies – ICBO, BOCA, and SBCCI. Today Hubbell Power Systems, Inc. has evaluation reports for helical products both in the US and Canada. ESR-2794 is an ICC-ES evaluation report that demonstrates Code compliance with the IBC, and CCMC Report 13193-R is an NRC evaluation report that demonstrates Code compliance with the Canadian Building Code. Copies of ICC-ES ESR-2794 and CCMC 13193-R Evaluation Reports are available on www.abchance.com.

- **Instructor's Curriculum for Foundation Engineering Courses**

In 2012, Hubbell Power Systems, Inc. contracted with Dr. Alan Lutenecker to develop an instructor's curriculum on helical piles and anchors to be used for foundation engineering courses for undergraduates. The curriculum includes all the information needed for two lectures, design examples and homework. Also included is a Student Guide, which serves as the "textbook" for students.



APPLICATIONS

In its simplest form, the helical pile/anchor is a deep foundation element, i.e., it transfers a structure's dead and live loads to competent soil strata deep below grade. This is the same for any deep foundation element such as driven piles, drilled shafts, grouted tendons, auger-cast piles, belled piers, etc. Therefore, helical piles/anchors can be used as an alternative method to drilled shafts and driven piles. Practical constraints, primarily related to installation, currently limit the maximum design load per helical pile/anchor to 100 kips in tension and 200 kips in compression, which means helical piles/anchors can resist relatively light to medium loads on a per pile/anchor basis, and much heavier loading when used in pile groups. But as is the case with virtually all engineering problems, more than one solution exists. It is the responsibility of the engineer to evaluate all possible alternatives, and to select the most cost-effective solution.

Today, helical piles/anchors are commonly used for residential and light commercial and heavy commercial construction, machinery/equipment foundations, telecommunication and transmission towers, tie-downs for wind and/or seismic forces, and virtually any application where site access is limited or remote. They have become the deep foundation of choice for walkways and boardwalks in environmentally sensitive areas, such as wetlands and protected forestland. In expansive soil areas, helical piles can save money and time when compared to expensive over-excavation and fill options. Helical piles/anchors do have several advantages (see following section) that make them the foundation of choice for many applications including these general categories:

- Machinery/Equipment Foundations
- Limited Access Sites
- Wind and Seismic Loading
- Replacement for Drilled/Driven Piles

ADVANTAGES of CHANCE® HELICAL PILES/ANCHORS

Each project has unique factors that determine the most acceptable foundation system. The following summarizes situations where helical piles/anchors present sensible solutions.

- **Projects Requiring Deep Foundations due to Weak Surface Soil**

Helical piles/anchors are designed as end-bearing piles which transfer loads to competent, load-bearing strata. Helical piles/anchors eliminate high mobilization costs associated with driven piles, drilled shafts or auger-cast

CHANCE® HELICAL PILE/ANCHOR ADVANTAGES TABLE 1-3

Summary of CHANCE® Helical Pile/Anchor Advantages	
<ul style="list-style-type: none"> • No need for concrete to cure • Quick, easy turnkey installation • Immediate loading • Small installation equipment • Pre-engineered system • Easily field modified • Torque-to-capacity relationship for production control 	<ul style="list-style-type: none"> • Install in any weather • Solution for: <ul style="list-style-type: none"> - Restricted access sites - High water table - Weak surface soils • Environmentally friendly • No vibration • No spoils to remove

piles. They also don't require spoils to be removed and for flowable sands, soft clays and organic soils, no casings are required, unlike drilled shafts or caissons. When using the CHANCE HELICAL PULLDOWN® Micropiles, you have not only end-bearing capacity, but also the additional capacity from the friction developed along the grout/soil interface.

• Flooded and/or Poor Surface Conditions

When surface conditions make spread footings impossible and equipment mobilization difficult, helical piles/anchors are a good alternative since installation requires only a mini-excavator, a rubber-tired backhoe or small tracked machine.

• Limited Access

In confined areas with low overhead, helical piles/anchors can be installed with portable equipment. This is particularly useful for rehabilitation work.

• Expansive Soils

The depth of expansive soils from the surface varies, but a typical depth is approximately 10 feet. The bearing plates of a helical pile/anchor are usually placed well below this depth. This means that only the small-cross-section shaft of the helical pile/anchor is affected by the expansive soils. The swell force on the shaft is directly proportional to the surface area between the soil and the shaft, and the swell adhesion value. Since helical piles have much smaller shafts than driven piles or auger-cast piles, uplift forces on helical piles are much smaller. Research by R.L. Hargrave and R.E. Thorsten in the Dallas area (1993) demonstrated helical piles' effectiveness in expansive soils.

• Bad weather installation

Because helical piles/anchors can be installed in any weather, work does not need to be interrupted.

• Contaminated soils

Helical piles/anchors are ideal for contaminated soils because no spoils need to be removed.

• Temporary structures

Helical piles/anchors can easily be removed by reversing the installation process. This makes removal of temporary structures simple.

• Remedial applications

Helical piles can supplement or replace existing foundations distressed from differential settlement, cracking, heaving, or general foundation failure. Patented products such as the CHANCE® Helical Pier Foundation System provide a complete solution. Hubbell Power Systems, Inc. uses patented products to attach the helical piles to existing foundations and either stabilize the structure against further settlement or lift it back to near original condition. This system is installed only by trained, authorized, and certified dealers/installing contractors.

Helical piles are ideal for remedial work since they can be installed by portable equipment in confined, interior spaces. Additionally, there is no need to worry about heavy equipment near existing foundations. And, unlike driven piles, helical piles are vibration-free. The building can continue to operate with little inconvenience to its occupants. Other deep foundation systems such as auger-cast piles disturb the soil, thereby undermining existing foundations.

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